BRIEF COMMUNICATION

STUDIES ON SOUTHERN AUSTRALIAN ABALONE (GENUS *HALIOTIS*) V. SPAWNING, SETTLEMENT AND EARLY GROWTH OF *H. SCALARIS*

This note describes the spawning cycle of *Haliotis scalaris* Leach and the settlement density and growth of juveniles of the species at West Island (35°37′00″S, 138°35′00″E), South Australia. This spawning cycle differs markedly from that previously described for the species at Tiparra Reef[1], South Australia and is therefore of considerable interest.

Samples of 9-12 sexually mature female *H. scalaris* 65-80 mm long were collected at Abalone Cove, West I., at about monthly intervals from February 1983-July 1984. The entire visceral mass was preserved in 10% formalin and sea-water and later sectioned in the laboratory. Cross-sections of the gonad and digestive gland were traced on transparent plastic, the cut-out sections weighed, and the respective areas of gonad and digestive gland calculated. A gonad index was then calculated with the formula Gonad index = 100 (Area of gonad)/(Total area of section). The annual reproductive cycle of this species at West I. proved to be synchronous within the population so that measurement of oocyte-ova diameters to distinguish the stages of the reproductive cycle was unnecessary (see Shepherd & Laws[1] for details of the method).

Sea surface temperature data were obtained with a mercury thermometer at about monthly intervals at West I.

A hand lens, designed for use underwater with about 3× magnification (the optics are described by Shepherd & Turner in prep.) was used to search for *H. scalaris* on crustose coralline algal substrate, the preferred substrate for settlement of this species (Shepherd & Turner in prep.). Searches were done for 60-100 minutes at about monthly intervals in the boulder habitat at West I. at 4-5 m depth and the lengths of all individuals to about 25 mm long recorded to 0.1 mm.

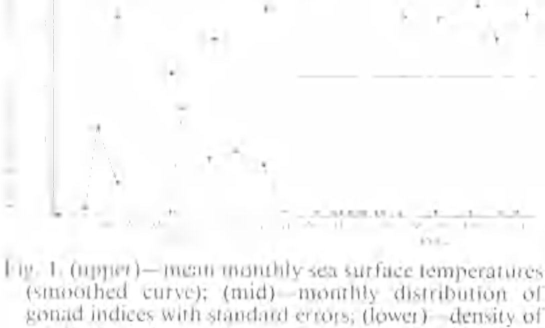

Fig. 1. (upper)—mean monthly sea surface temperatures (smoothed curve); (mid)—monthly distribution of gonad indices with standard errors; (lower)—density of small *H. scalaris* ≤5 mm at study site.

Changes in the mean monthly gonad index of *H. scalaris* from February 1983-May 1984, together with sea surface temperature data are given in Fig. 1. The index increases from winter to mid-summer and declines abruptly from late summer through the autumn. The increase indicates maturation and increase in size of oocytes in the gonad, and the decline of the index indicates the onset of synchronous spawning in the population. Spawning appears to have commenced later in 1983 than in 1984 and to have been more complete. In 1984 the gonad never became completely spent but commenced to increase in size again in July.

Thus *H. scalaris* has a late summer to autumn spawning season (February-May) which is synchronous throughout the population, and appears to begin at about the time of maximum summer sea temperature. This spawning cycle contrasts strikingly with the asynchronous cycle of *H. scalaris* at Tiparra Reef where spawning potentially occurs throughout the year.

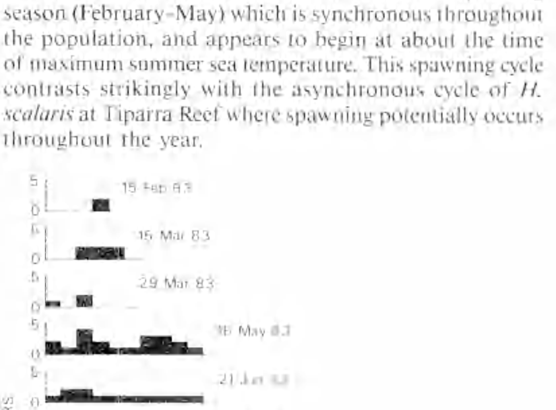

Fig. 2. Length frequency distributions for *H. scalaris* at West Island from February 1983 to May 1984.

Of the various environmental factors that are known to influence the spawning cycles of abalone e.g. temperature,[2] photoperiod,[3] and food abundance[3,4] only the latter shows a marked difference between the two sites. Drift food algae are seasonally in short supply at Tiparra Reef but abundant throughout the year at West I.,[5] but this is unlikely to account for the differences in spawning between the sites. Further studies of *H. scalaris* are necessary, especially in other parts of its geographic range, to elucidate the problem. *H. rubra* Leach also shows marked, but unexplained, differences in spawning cycle between these two sites.[1] The only other abalone species that we know of with a similarly variable spawning cycle between localities is *Haliotis rufescens* Swainson.[6,7]

The density of small *H. scalaris* (measured in mean numbers of individuals ≤5 mm recorded per 15 min searching time is given in Fig. 1. Maximum settlement apparently occurred in March 1983. The relatively high densities recorded from July to September 1983 are of larger individuals (3-5 mm) and do not indicate recent settlement.

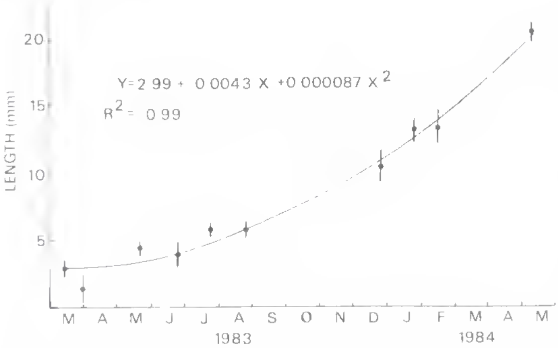

Fig. 3. Plot of mean length (with standard errors) of 1983 cohort of *H. scalaris* from March 1983 to May 1984. A polynomial regression of best fit to the means is shown.

Length frequency data from February 1983-May 1984 (Fig. 2) show that very small *H. scalaris* (1-3 mm long) were present from February-June 1983 indicating settlement in that period. This is in good agreement with the spawning season described above. No small *H. scalaris* were found in the 1984 spawning season, suggesting settlement was very poor and not detectable.

Shepherd (in prep.) associated the similar poor recruitment of *H. laevigata* Donovan at West I. in 1984 with the lower maximum summer sea temperature in 1984 compared with 1983. The settlement failure of *H. scalaris* in 1984 may also be associated with lower summer sea temperatures in that year or with the incomplete spawning or a combination of them.

The change in mean size of the 1983 cohort from March 1983-May 1984 (Fig. 2) enables an estimate to be made of the growth of the cohort in the first year. The equation of best fit empirically fitted to the data is given in Fig. 3. On the basis that settlement occurred between 1 February and 30 June 1983, a mean birth date for the cohort can be fixed at 15 April 1983. From the regression (Fig. 3) the mean length of the one year old animal is therefore about 18.5 mm. Comparison of this growth rate with that of other haliotids[8] suggests that it is relatively rapid for a species whose maximum size (at West I.) is only about 100 mm.

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[1]**Shepherd, S. A. & Laws, H. M.** (1974). Aust. J. Mar. Freshw. Res. 25, 49-62.

[2]**Kikuchi, S. & Uki, N.** (1974). Bull. Tohok. Reg. Fish. Res. Lab. 33, 69-78.

[3]**Kim, Y. & Cho, C.** (1976). Bull. Korean Fish. Soc. 9, 61-68.

[4]**Giese, A. C.** (1959). Ann. Rev. Physiol. 21, 547-576.

[5]**Shepherd, S. A.** (1973). Aust. J. Mar. Freshw. Res. 24, 217-257.

[6]**Giorgi, A. E. & De Martini, J. D.** (1977). Calif. Fish and Game 63, 80-94.

[7]**Lee, T. Y.** (1974). Publ. Mar. Lab. Busan Fish. Coll. 7, 21-50.

[8]**Shepherd, S. A. & Hearn, W. S.** (1983). Aust. J. Mar. Freshw. Res. 34, 461-75.

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